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# Types of wounds on those rescued from the avalanche disaster

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## ABSTRACT

**Aims**: The most crucial step in rescue operations is the safety of rescuers. Two critical points were addressed to contribute to the literature. The first point is that the intervention of the rescuers together with the local people before ensuring the safety may result in more catastrophic disasters, and the second point is the course of avalanche victims after being rescued.

**Methods**: After the avalanche disaster that occurred in February 2020, the team, who went to help, was exposed to the avalanche disaster that happened again. A total of 65 people were rescued with injuries in both disasters. Data of patients admitted to neighboring hospitals (secondary and tertiary healthcare facilities) in Van province and 112 Emergency Health Services data were recorded.

**Results**: 41 avalanche victims died, 40 were out of the hospital and one victim in a local secondary healthcare facility. Among the 65 rescued people, one was admitted to the intensive care unit, 8 underwent emergency surgery, 40 were admitted to the hospital for follow-up purposes, and 16 were discharged after initial treatment in the emergency department. Of the patients, 63 were male, one was female, and the mean age was 36.39 years.

**Conclusion**: The primary strategy in an avalanche disaster is to stay in the safe zone. As with all major disasters, various types of injuries can occur. Although the priority is to reduce deaths, determining the most common injury areas of individuals exposed to disasters will help prevent possible deaths and disabilities.

**Keywords**: Avalanche, emergency, rescue

## INTRODUCTION

Avalanche is defined as the swift motion of a mass of snow down a mountainside with an approximate speed of 90-120 km after a trigger.[1]

Avalanche is a significant problem in cold and snowy countries.[2] The frequency of avalanche disaster varies depending on the climatic and geographic characteristics of countries.[3] Although the avalanche mortality rate ranges between 6% and 43%, it is estimated that the exact figures are much higher.[4,5] The popularity of winter tourism and mountain climbing has gradually increased worldwide.[3] Outdoor activities in mountainsides covered with a snow mass pose severe risks for the participants.[4]

It is known that humans trigger approximately 90% of avalanche disasters in Europe and North America.[3] The avalanche victims would die of asphyxia and hypothermia approximately within 15-20 minutes even if they survived the initial trauma.[2] In various studies, asphyxia has been ranked first among other causes of death in avalanche victims, with a reported rate of 75% to 91.7% whereas the second most common cause of death is trauma.[6-8] Despite these reports, the cause of death remains unknown in some cases.[5]

The most crucial step in rescue operations is the safety of rescuers. The present study evaluates cumulative injuries in the rescuers buried under avalanche during a rescue operation for two avalanche victims to emphasize the safety of rescuers. The present study addresses two critical points to contribute to the literature. The first point is that the intervention of the rescuers together with the local people before ensuring the safety may result in more catastrophic disasters, and the second point is the course of avalanche victims after being rescued.

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## METHODS

The data of the patients admitted to the surrounding hospitals (secondary and tertiary healthcare facilities) in the Van province after the avalanche disaster in February 2020, and the data of 112 Emergency Health Services were recorded retrospectively. Demographic data, injury site, first interventions, initial vital signs, and blood parameters were recorded.

The study was carried out with the permission of the Van Yüzüncü Yıl University Hospital Scientific Researches Evaluation and Ethics Committee (Date:22.05.2020, Decision No: 2020/03-60). We obtained an informed consent form all patients for procedure. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

### Statistical Analysis

Among the studied parameters, the descriptive statistics for continuous variables were expressed as mean and standard deviation, and the categorical variables were expressed as number and percentage. SPSS 20 statistical software package was used in statistical analysis.

## RESULTS

In the avalanche disaster, a total of 41 victims died and 65 victims were rescued. Of those rescued with injuries, 64 were men and 1 was a woman and the mean age was 36.39 years.

A total of 41 avalanche victims died, 40 out of the hospital and one victim in a local secondary healthcare facility (**Figure 1**).

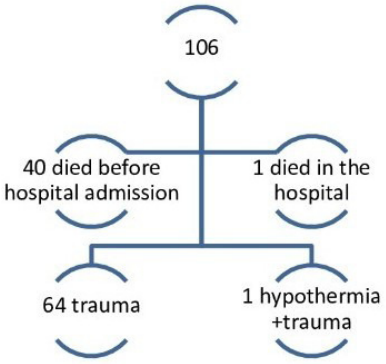


Figure 1. Distribution of the aftermath in avalanche victims

Among the 65 rescued people, one was admitted to the intensive care unit, 8 underwent emergency surgery, 40 were admitted to the hospital for follow-up purposes, and 16 were discharged after initial treatment in the emergency department (**Figure 2**).

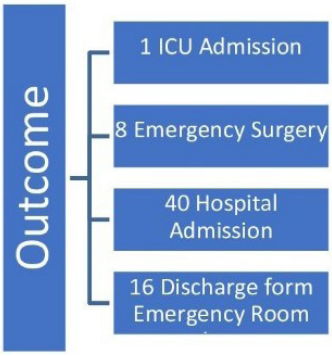


Figure 2. Distribution of the hospital course in the avalanche victims

The patients with an injury affecting only one organ and system were considered to have sustained isolated trauma, and those with multiple injuries were considered to have sustained multiple trauma (**Figure 3**).

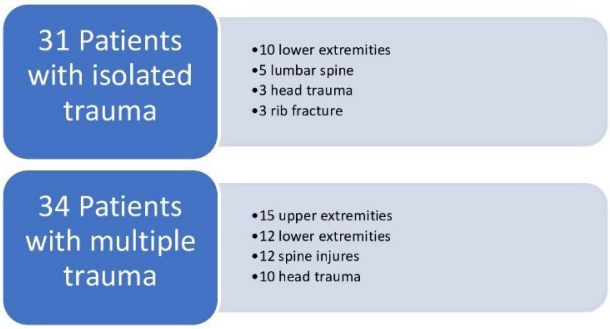


Figure 3. Type of injuries

Since almost all avalanche victims had muscle injuries, WBC and CK were elevated as shown in **Table 1**.

**Table 1.** Mean blood parameters of the casualties

| Parameter | Average/Reference Value |
|---|---|
| White blood cell (WBC) | 16.11 x 10^3uL (4.5-11 x 10^3uL ) |
| Hemoglobin (Hgb) | 15.5g/dL (male: 14-16.5; female 12-15 g/dL) |
| Hematocrit (Htc) | %44.6 (male: 42-52%; 35-47%) |
| Potassium (K) | 4.2mmol/L (3.5-5 mEq/L) |
| Calcium (Ca) | 8.6mmol/L (8.5-10.5 mg/dL) |
| Urea | 24 mg/dL (8-25 mg/dL) |
| Creatinine (Cr) | 0.82 mg/dL (0.6-1.3 mg/dL) |
| Alanine aminotransferase (ALT) | 32u/L (male: 10-55; female 7-30 u/L) |
| Aspartate aminotransferase (ALT) | 32u/L (male: 10-40; female 9-25 u/L) |
| Creatine kinase (CK) | 674u/L (male: 38-174; female 26-140 u/L) |
| Creatine kinase MB (CK-MB) | 33u/L (CK*0-0.05) |
| Troponin I | 0.09um/L (<0.6 ng/mL) |

The patients who underwent emergency surgery after being admitted to the emergency department had thoracic spine fracture (T10) with compression to the medulla spinalis, extremity, and forearm injuries with damage to the vessel-nerve package, intracranial hemorrhage, comminuted knee fracture, shoulder and leg injury with comminuted fracture, shoulder-leg-thoracic spine injury, eye-upper extremity and leg injuries.

The patients discharged from the emergency department had forearm fracture, rib fracture, foot fracture, fracture of the lateral process of the lumbar vertebra, knee injury, facial injury, superficial head injury, neck injury without a fracture, hand and leg injury, hand and lumbar injury, knee injury, and thoracic injury.

One patient admitted to the intensive care unit had facial, shoulder, lung, and thoracic vertebra injury.

## DISCUSSION

Although the avalanche is a fatal natural disaster, educating and informing the people may reduce unjust suffering.[4,6,9] The number of avalanche victims increases gradually due to people's engagement in mountain climbing sports, transportation, military operations, rescue operations, and dense residential areas in mountainsides at high altitude.[6]

The reported mortality rate associated with the avalanche disaster varies between 4% and 50%.[7,10] The mortality rate associated with trauma in avalanche victims was reported to be 24% in Canada and 5.6% in Europe.[6,7]

The knowledge of the causes of death and injuries in avalanche victims would guide rescue and resuscitation guidelines.[8] The people buried under a mass of snow in an avalanche disaster may come across rocks, trees, and palisades.8 The cause of death should not be related to only one factor. Asphyxia, trauma, and hypothermia can be observed in all cases at different severity levels.[6] In an avalanche in Utah, the cause of death was considered to be asphyxia in 72%, trauma in 19%, and the combination of asphyxia, hypothermia, and trauma in 9% of the victims.[4]

The overall mortality rate varies depending on the activity engaged, time spent under the snow mass, the physical status of the victim, and the equipment.[6] The death rate is approximately 50% in the victims buried entirely under the snow mass and 3-4% in those who were not completely buried.[11] Ninety percent of the victims completely buried in avalanches survive if they are rescued within 15 minutes.[10] The victims killed by nontraumatic causes gradually experience hypoxia, hypercapnia, and hypothermia.[12] Of the victims presented in the study, 40 were found dead after the incidence, and one casualty died after an admission to a secondary care hospital. The rate of mortality per total number of victims was 33.06%.

The avalanche victims are often healthy and young males. The mean age ranges between 25 and 33 years.[4,6,8] The mean age in the present study was 36.39 years. The high mean age can be explained by the fact that a considerable number of victims were from the local people. Males are the predominant gender in previous studies. The rate of female victims ranges from 5.3% to 6%.[4,8] The number of female victims was 2 in the present study, comprising 3.1% of all victims.

Trauma is the most common cause of death after asphyxia.[8] This rate varies depending on the geographic characteristics of the incident site. The data dramatically vary depending on the area's topographic structure, the composite structure of snow, and the incident site being a forested or rocky terrain.[12] The avalanche victim can hit trees and rocks and fall down a cliff while rolling in a large mass of snow.[6,8] Of avalanche deaths, 57% are caused by internal and 43% are caused by external injuries.[4] Sixty-five casualties in the present study had signs of trauma at various degrees. When the number of injured organs was evaluated, 31 out of 65 casualties had isolated trauma while 34 casualties with multiple trauma had injuries in different organs and systems.

Some authors argue that trauma is the cause of death in one-third of the victims.[4,6] It was reported that approximately 43% of the deaths during a 10-year period in Switzerland were caused by trauma.[13] The leading cause of death in trauma cases is reported to be the brain injury.[13] Head injury has been observed in 42% of deaths caused by trauma.[6] Therefore, wearing a helmet will reduce the risk of head trauma. According to the results of clinical and autopsy studies, trauma most commonly affects the head, spine, chest, and extremities.[7,8,12] According to the Canadian data, the injury site is the chest in 46% and head in 42% of the victims.[6] The extremities, spine, and head were the most commonly affected body sites in the present study. The casualty admitted to the intensive care unit had facial, shoulder, thoracic, and vertebral injuries.

The rescue team must be complete and ready before starting the rescue operation.[14] The intervention to avalanche disaster must begin with the safety of the medical management team.[12]

The primary strategy in avalanche disaster is the stay in the safe zone. Rescue training must have been received, and the essential equipment must be carried.[2] The rescue operation must be delayed or stopped in hazardous areas, severe weather conditions, and if there is a risk of new avalanche.[12,15] The victims in the present study were composed of the rescue team and the local people who dispatched to the area to rescue two people buried in a previous avalanche. Despite severe weather and the occurrence of a second avalanche disaster, running the rescue mission, increased the number of victims to 106. Thus, rescue operations must be delayed until favorable conditions have been achieved.

Taking fast and effective actions increases the chance of survival.4 The involvement of the people in the neighborhood until the professional rescue team has arrived increases survival.[3] The access to the disaster site is sometimes challenging.[16] The terrain is screened for evidence when the rescue operation has been initiated. A connection line is tested if the rescuer is using a receiver device. The strategic area is determined, and the search and rescue operation is started with a scoop.[14] Resuscitation must be performed within 35 minutes after the victims buried under snow have been recovered.[17]

Rescue strategies along with appropriate rescue equipment increase the chance of survival.[4,8] It is stated that avalanche airbags reduce mortality.[18] Therefore, it is suggested that people who may be exposed to avalanche travel with at least one partner, an airbag, and a walkie-talkie.[4]

The use of helicopters is effective in areas with limited ground access; however, it must be realized that the helicopter's sound and vibration waves may trigger a second avalanche.[16] Air rescue teams among the avalanche rescue teams must be specialized.[16] The triggering of a new avalanche during the operation can be attributed to heavy snow and steep and rocky geographic features of the terrain.

A rapid assessment must be performed, and the vital functions must be analyzed upon reaching the victim. It must be realized that the heart rate may be weak, slow, and irregular due to hypothermia.[19] Only one hypothermic casualty was admitted to the hospital as the first intervention to the immersed victims was made at the incident site. The body temperature in the hospitalized patient returned to normal by passive warming techniques.

The possibility of bodily trauma must not be overlooked in avalanche victims, and the rescuers must implement multiple trauma protocols.[20,21] A proper body position must be given due to the possibility of spinal trauma after recovering avalanche victims. If resuscitation attempts have been initiated, minimum intervals must be given between chest compressions. A resuscitation procedure must be performed because the victim may also have hypothermia and asphyxia.[3,6] Because the most commonly affected body site is the spine in the casualties with isolated and multiple injuries, a cervical collar and spine support must be used until it is proven otherwise.

In the present study, the patients who underwent emergency surgery after being admitted to the emergency room had thoracic spine fracture (T10) with compression to the medulla spinalis, extremity, and forearm injuries with damage to the vessel-nerve package, intracranial hemorrhage, comminuted knee fracture, shoulder and leg injury with comminuted fracture, shoulder-leg-thoracic spine injury,

eye-upper extremity and leg injuries. Sixteen patients were discharged after the treatment and follow-up in the emergency department.

Resuscitation may not be performed when the victim has fatal injuries, or the body has been frozen so that chest compression becomes impossible. Resuscitation must be continued regardless of the duration in cases with a patent airway.[17] The rescued victims must be transported initially to the nearest healthcare facility or trauma facility by helicopter or ground ambulance, or snow bike if possible.[11,12] All casualties reported in the present study were transported to the hospital by a ground ambulance.

### Limitations

The present study's limitations are that different rescue teams intervened the avalanche victims, the casualties were treated in different hospitals, and some data were not appropriately kept.

## CONCLUSION

It is of particular importance to reduce deaths by increasing avalanche awareness and educations in the terrain. The time to intervention is critical as death and injuries suddenly occur in avalanche disaster. The dispatch of the rescue teams to the incident site should be rapid and appropriate. No intervention should be made until safety measures have been taken. The rescue plan should be made as per the geographic characteristics of the terrain and weather conditions, and the victims should be transported to the treatment facilities in the shortest time possible. Regardless of the effectiveness of the intervention to avalanche disaster, the most important protection method is to stay away from risky areas.

## ETHICAL DECLARATIONS

**Ethics Committee Approval:** The study was carried out with the permission of the Van Yüzüncü Yıl University Hospital Scientific Researches Evaluation and Ethics Committee (Date:22.05.2020, Decision No: 2020/03-60). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

**Informed Consent**: All patients signed and free and informed consent form.

**Referee Evaluation Process:** Externally peer-reviewed.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

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**Author Contributions:** All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

## REFERENCES

1. Tremper B. Staying alive in avalanche terrain. Mountaineers books; 2018.
2. McIntosh SE, Little CE, Seibert TD, Polukoff NE, Grissom CK. Avalanche airbag post-burial active deflation - the ability to create an air pocket to delay asphyxiation and prolong survival. *Resuscitation*. 2020;146:155-160.
3. Stich A, Blanco J. Backcountry triggered avalanches: a summary of risk factors, causes of death, and wilderness medical management. *UBCMJ*. 2020:11(2):27-29.
4. McIntosh SE, Brant-Zawadzki G, Milliner BH, et al. Cause of death in Utah avalanche fatalities, 2006–2007 through 2017-2018 winter Seasons. *Wilderness Environment Med*. 2019;30(2):191-194.
5. Sheets A, Wang D, Logan S, Atkins D. Causes of death among avalanche fatalities in colorado: a 21-year review. *Wilderness Environment Med*. 2018;29(3):325-329.
6. Boyd J, Haegeli P, Abu-Laban RB, Shuster M, Butt JC. Patterns of death among avalanche fatalities: a 21-year review. *CMAJ*. 2009;180(5):507-512.
7. Hohlrieder M, Brugger H, Schubert HM, Pavlic M, Ellerton J, Mair P. Pattern and severity of injury in avalanche victims. *High Altitude Med Biol*. 2007;8(1):56-61.
8. McIntosh SE, Grissom CK, Olivares CR, Kim HS, Tremper B. Cause of death in avalanche fatalities. *Wilderness Environment Med*. 2007;18(4):293-297.
9. Atkins D, AB R. A history of Colorado avalanche accidents, 1859-2006. *ISSW Proceedings, Telluride, CO*. 2006:287-297.
10. Brugger H, Durrer B, Adler-Kastner L, Falk M, Tschirky F. Field management of avalanche victims. *Resuscitation*. 2001;51(1):7-15.
11. Haegeli P, Falk M, Brugger H, Etter H-J, Boyd J. Comparison of avalanche survival patterns in Canada and Switzerland. *CMAJ*. 2011;183(7):789-795.
12. Kornhall DK, Martens-Nielsen J. The prehospital management of avalanche victims. *BMJ Military Health*. 2016;162(6):406-412.
13. Radwin MI. Unburying the facts about avalanche victim pathophysiology. *Wilderness Environment Med*. 2008;19(1):1-3.
14. Van Tilburg C, Grissom CK, Zafren K, et al. Wilderness medical society practice guidelines for prevention and management of avalanche and nonavalanche snow burial accidents. *Wilderness Environment Med*. 2017;28(1):23-42.
15. Paal P, Milani M, Brown D, Boyd J, Ellerton J. Termination of cardiopulmonary resuscitation in mountain rescue. *High Altitude Med Biol*. 2012;13(3):200-208.
16. Lunde A, Tellefsen C. Patient and rescuer safety: recommendations for dispatch and prioritization of rescue resources based on a retrospective study of Norwegian avalanche incidents 1996–2017. *Scandinavian J Trauma Resusc Emerg Med*. 2019;27(1):1-8.
17. Brugger H, Durrer B, Elsensohn F, et al. Resuscitation of avalanche victims: evidence-based guidelines of the international commission for mountain emergency medicine (ICAR MEDCOM): intended for physicians and other advanced life support personnel. *Resuscitation*. 2013;84(5):539-546.
18. Haegeli P, Falk M, Procter E, et al. The effectiveness of avalanche airbags. *Resuscitation*. 2014;85(9):1197-1203.
19. Brugger H, Paal P, Boyd J. Prehospital resuscitation of the buried avalanche victim. *High Altitude Med Biol*. 2011;12(3):199-205.
20. Fieler J. North-Norwegian avalanche victims: a retrospective observational study, Master's Thesis. Universitetet i Tromsø, 2013.
21. McCammon I. The role of training in recreational avalanche accidents in the United States. Paper presented at: Proceedings of the International Snow Science Workshop, Big Sky, Montana, October 2–6, 2000. pp. 37-45.